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Joseph Pilates' method and possibilities of its application in physiotherapy

Metoda Josepha Pilatesa oraz możliwości jej zastosowania w fizjoterapii

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Abstract
This article presents a theoretical basis for techniques of physical exercises developed by Joseph Pilates. The method, as part of the so-called Body Mind Exercises group, first gained recognition among professional dancers, actors and choreographers but has become more popular and is now regularly applied in sport, fitness and physiotherapy. The paper presents methodological and biomechanical principles of this exercise system (oriented to strengthening the whole muscular system, both deep – stabilizing and superficial – moving parts, interaction „from the core" on the slings forming superficial musculo-fascial system, the work in open and closed kinetic chains). Historical background of the method and principles of performing the exercises using the Pilates Method (concentration, control, centering, breathing, postural alignment, flow, stamina, relaxation) is provided. The paper presents instruments (the Cadillac, the Reformer) and accessories (Swiss Ball, Overball, Tubings) that can be used to enhance the exercise program in the discussed activity improvement system. The final part of the article includes a critical review of physiotherapy and sports medicine literature pertaining to application of the presented method in kinesitherapy of patients at different ages, particularly in elderly people. Prior experience of physiotherapists using this technique in their work has indicated a possibility of applying the technique in the therapy of patients with various neuro-muscular dysfunctions and in sports medicine. The authors hope to encourage the environment of physiotherapists to enhance their professional skills with elements of Pilates' method.

Słowa kluczowe
Pilates, ćwiczenia, fizjoterapia, medycyna sportowa

Streszczenie
Celem pracy jest przybliżenie teoretycznych założeń techniki wykonywania ćwiczeń fizycznych opracowanej przez Josepha Pilatesa. Metoda ta, należąca do grupy tzw. *Body-Mind Exercises*, początkowo znana i ceniona głównie w kręgach zawodowych tancerzy, aktorów i choreografów, zyskuje rosnącą popularność i zastosowanie w sporcie, fitnessie i fizjoterapii. Niniejsze opracowanie ma za zadanie przybliżyć czytelnikom podstawy metodologiczne i biomechaniczne tej metody ukierunkowanej na wzmocnienie całego układu mięśniowego: części głębokiej – stabilizacyjnej oraz powierzchownej – ruchowej, oddziaływanie „od wewnątrz ciała" na powierzchowny system mięśniowo-powięziowy, pracę zarówno w zamkniętych jak i otwartych łańcuchach biokinematycznych. W artykule przedstawiono rys historyczny oraz informacje dotyczące zasad wykonywania ćwiczeń według techniki Pilatesa (koncentracja, kontrola, silne centrum, oddychanie, pozycja ciała, płynność, wytrzymałość, relaksacja). Omówione zostały przyrządy (*Cadillac, Reformer*) oraz przybory (piłka szwajcarska, *overball*, taśmy i linki elastyczne), które mogą zostać wykorzystane do wzbogacenia programu ćwiczeń w omawianym systemie usprawniania ruchowego. Dokonany został krytyczny przegląd piśmiennictwa z zakresu fizjoterapii i medycyny sportowej, dotyczący możliwości zastosowania omawianej metody w kinezyterapii pacjentów w różnym wieku, a zwłaszcza osób starszych. Dotychczasowe doświadczenia fizjoterapeutów stosujących tę technikę w swojej pracy, wskazują na możliwość jej wykorzystania w usprawnianiu pacjentów z różnymi dysfunkcjami nerwowo-mięśniowymi oraz w medycynie sportowej. Autorki mają nadzieję, że zachęcą środowisko fizjoterapeutów do poszerzenia swojego warsztatu pracy o elementy metody Pilatesa.

Authors' contribution: A – project of the study, work; B – collection of the data, information; C – statistical analysis; D – data interpretation; E – preparation of the manuscript; F – literature query; G – obtaining funds

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INTRODUCTION

A quotation from Friedrich Schiller's philosophy „It is the mind which builds the body" can serve as a motto for Pilates exercises. According to this, the method aims at increasing the awareness of own body and is frequently referred to as „intelligent gymnastics". In its original form, this type of physical training was designed in the twenties of the previous century by a German sportsman Joseph Pilates and was subsequently being developed during his entire life. The method, originally known and appreciated mainly within a circle of professional dancers, actors and choreographs has gained great popularity and application in sport, fitness and physiotherapy. It is estimated that solely in the United States of North America, the number of persons exercising according to the principles of Pilates' technique was 1.7 million in 2000 and rose to 10.5 million in 2004[1,2].

Pilates' exercises belong to a group of so-called Body-Mind Exercises. Each motion in this system requires engagement of both mind and body. The method combines principles of exercises from the Eastern cultures (control of motion by the mind, precision, body centre as the main energy point, proper breathing and relaxation – *Hatha-Yoga*) and the Western cultures (endurance training, stabilisation – classical ballet). According to Crews[1], the described training concept assumes reinforcing the muscles of the whole body, however, it especially emphasises conscious action exerted on deep muscular structures. Appropriate functioning of those structures is essential for normal stabilisation during motion.

In contrast to traditional force and endurance training, exercises used in Pilates' method are performed simultaneously at three planes: saggital, frontal and axial (e.g. during circle-like movements of the limb). In order to eliminate the risk of trauma, motor tasks with predominance of concentric-eccentric contractions are performed. Resistance exercises with instruments constructed based on Joseph Pilates' idea are also used (e.g. Cadillac, Reformer)[3].

In the described system of exercises, it is emphasised that physical training be performed in harmony, with preserved balance between stretching and reinforcing the muscles and their fascia as well as balance between joint stability and mobility[4]. It is strived to increase the force of body centre – „the core" and to form the muscles in order to achieve optimal articular stability and mobility[3].

JOSEPH HUBERTUS PILATES – FOUNDER OF THE SYSTEM

He was born in 1880 in Germany near Düsseldorf. During his childhood, he was often ill and suffered from diseases including asthma and rickets. Despite this fact, thanks to his ambition and perseverance, as a teenager, he reached high level of physical agility. He did many sports: skiing, swimming, diving, boxing, he also practised yoga and eastern martial arts. Since 1912, he began to work in England as a professional boxer as well as an instructor of self-defence techniques for Scotland Yard detectives. After the outbreak of the World War I, he was interned as a German citizen in a camp, where he continued to fathom his knowledge on physical development of the body and – working as a male nurse – he was using it to conduct rehabilitation in patients of the camp hospital. He experimented with performance of exercises with springs attached to hospital beds so that patients could reinforce their muscles before standing and walking. These experiences resulted in construction of classical instruments such as Universal Reformer, Cadillac, used also contemporarily in Pilates' schools. During flu epidemic in 1918 in England, nobody of the patients who was performing physical exercises according to Pilates instructions died, which reinforced Pilates' conviction as to the effectiveness of his method. After the World War I, he came back to Germany, where he started cooperation with Rudolf von Laban, an outstanding choreograph, founder of modern creative and expressive gymnastics. Pilates' refusal to train soldiers of the German army forced him to leave for the United States of America. During his trip, he met a nurse, who later became his wife. They founded together a gymnastic studio in New York that was localised close to the New York City Ballet. Injured dancers were their first customers, who could quickly return to full physical agility thanks to rehabilitation exercises performed according to the new method. With time, Pilates' technique became broadly famous and gained appreciation. Popularity of this gymnastic system was foreseen by its founder, who spoke: „I am ahead of my time by fifty years". Joseph Pilates died at the age of 87 years. The words he spoke by the end of his life are meaningful: „Now I know – I can't be wrong. The whole country, whole world should perform my exercises. People will be happier then."[5,6,7,8].

PRINCIPLES OF THE PILATES' TECHNIQUE

Proper performance of the exercises in Pilates' technique requires conformance to the following rules:

Concentration

It assumes maximum concentration on performance of a given exercise in a proper way.

To achieve this, movement visualisation is used – imagination of a motion before and during its conduction[1].

Control

During the exercises, the mind controls the way they are performed so that they are not harmful. Fatigue of the muscles is avoided by precise performance of a small number of repetitions of exercises (usually 10 in a set), with graded level of difficulty and introduction of respiration and stretching exercises into training sessions. In the Pilates' method, control of the mind and motion are to serve to reconstruct normal nerve-muscle coordination based on a profound involvement of consciousness in performing motor activities[1,4,7].

Powerful body centre - core

A movement in each exercise is preceded by muscle tension and achievement of a so-called „stabilisation cylinder" around the spine. It is formed primarily by deep muscle-fascial structures: **anteriorly** - muscles of the abdomen (transverse muscle and internal oblique muscles), **posteriorly** - multifidus muscle and transverse muscle of loin, **superiorly** - diaphragm and **inferiorly** – muscles of pelvic fundus. In EMG studies, it was confirmed that muscles of pelvic fundus, transverse muscle of abdomen and multifidus muscle act synergistically[9,10]. In the technique of Pilates, it is strived to their co-activation by tensing the transverse muscle of abdomen, which is practically achievable by following the instruction: „pull the umbilicus towards the spine" and by tensing pelvic fundus muscles. The latter mode of activation of the „stabilisation cylinder" seems to be more difficult because of the fact that, according to some authors, as many as 50% of women are unable to consciously tense the muscles of the pelvic fundus and disturbances of the function of this important muscle group of „deep stabilisers" is observed in 80% of women[11]. In the described method, beginning with the first classes, learning of proper activation of body centre is introduced. It is emphasised that muscle tone should be moderate, that is should constitute approximately 30% of maximum muscle tone. In other words – the tone should be at „2" in a scale, where 0 – minimum tone, 5 – maximum tone[11,12].

Many classical exercises by Pilates, e.g. „circles with one leg", especially engages in the movement the muscles directly affecting function of the hip joints. This results from the assumptions of reaching the „strong core", as the function of adductors and abductors of the hip and of gluteal and latissimus dorsi muscles (because of localisation of their origins on the spinal column and the pelvis) affects stabilisation of the body centre. A well stabilised spine with the pelvic girdle is a fundament of economical motion of humans in the erect posture. This favours elimination of sliding lateral movements within spinal articulations and enables performance of more unimpeded movements of the extremities. Muscular structures located deeply in the walls of the body, close to its core, originating directly on the spine or the pelvis are referred to as core muscles. Their principal activity involves formation of strong trunk stabilisation essential for performance of basic motor activities such as standing, sitting, walking, leaning over, or catching and lifting objects[1].

Development of civilisation resulting in a sedentary style of living, trauma or disturbances of muscular balance due to bad motor habits lead to weakness and restriction of function of these „deep body stabilisers". In case of disturbances in body core muscles function, stabilisation of the trunk is overtaken by large muscle groups located externally (trapezius muscle, erector muscle of spine - superficial layers). This leads to chronic tension and fatigue of these structures, which, in turn, results in pain. Activation of deep trunk muscles characteristic for the described method, preceding initiation of each exercise, repeated many times and consolidated during subsequent training sessions aims at formation by the patient an automatic and functional stabilisation of the trunk and ergonomics, ease and lightness in daily-life motor activity.

Respiration

Appropriate coordination of breathing with performance of an exercise constitutes the first rule introduced in teaching the Pilates' technique. Proper respiration favours better blood oxygenation thus improving functioning of the mind and movement control. Rib-diaphragmatic breathing is used, accentuated at forced expiration with simultaneous traction of the umbilicus towards the spine. At inspiration, the thorax is widened in three planes (three-dimensional breathing), at forced expiration, oblique muscles of abdomen are additionally involved, which enables better pulmonary ventilation (Pictures 1 and 2). The crucial movement of an exercise is performed during expiration at proper spinal stabilisation[4,6].

Postural alignment

In the described method, conscious striving to maintenance of proper body posture during all phases of exercise is emphasised. All movements are performed in neutral positions, without enhancing of physiological spine curvatures. It is stressed out that the head should be positioned without its protrusion in the protraction movement and the shoulders should be positioned without their elevation resulting from excessive tension – „receding the ear from the

Photo 1

Rib-abdominal respiration (inspiration)

Photo 2

Rib-abdominal respiration (expiration)

arm". The scapulae should be slightly retracted towards the buttocks direction, the pelvis should remain in a neutral position, and body core should be tensed by „pulling the navel to spine". While standing, it should be kept in mind to actively elongate the body along the axis of the spine – „receding the top of the head from the feet", slightly flex the legs without blocking the knee joints and symmetrically load both feet positioned at a distance of pelvis width from each other. These assumptions as well as the other, resulting from striving for a neutral body position, are obligatory during performance of exercises at other baseline positions. For example, during lying supine on a side, the region round the waist should be slightly elevated over the ground in order to better stabilise the pelvis while the feet should be kept in plantar flexion (the so-called „active feet") (Pictures 3 and 4). In the Pilates technique, it is also emphasised to correctly change positions for the exercises, e.g. transition from standing to lying down on the back is performed by the so-called „rolling of the spine"[1,4,12].

Flow

The rate of exercises in the Pilates' system is moderate, depending on the precision of the performed movement and on individual respiration rhythm. Exercises should be performed at proper concentration and all body movements, including those of transitions between positions, should be performed fluently, with maintenance of a flow. This positively affects safety during exercises, even for persons who experienced injuries[1,4,7].

Stamina

Exercises are conducted at a training load adjusted to abilities of the exercising persons. In case of group exercises, it is recommended to divide the group into beginners and advanced subgroups. Classical Pilates' exercises, e.g. „a hundred", are designed in several versions, appropriately for skill level of the exercising persons (Figure 1). In the method, it is aimed to achieve an increase in general endurance of the whole muscular system in the distal system – peripheral with regard to the body core.

Relaxation

Acquisition of skills of conscious relaxation of selected muscle groups is an essential component of correct exercise performance in Pilates' method. According to the principles of this system, movement is linked to concentration of the mind and respiration; when performed smoothly but precisely, it leads to paving new, more ergonomic movement behaviours as well as it provides measurable psychological advantages by reducing stress level[1,4].

FORMS OF EXERCISES IN PILATES' TECHNIQUE

In the classical Pilates method, exercises are performed on a gymnastic mat or with use of special instruments constructed based on the idea of the founder of the system.

A) Exercises performed using a mat (mat-based Pilates) are the most popular form. Exercises are performed at various positions taking advantage of the gravity and the weight of the exercising person, yet, all the time with maintenance of the spine at neutral position (without deepening the physiological curvatures) and with application of the above principles of the technique[7].

B) Exercises using instruments (equipment-based Pilates).

Universal Reformer. It is a sort of a bed enabling performance of exercises at various body positions. The bed is equipped with four exchangeable springs, which creates a possibility of performing approximately 50 resistance-exercises aiming at controlled reinforcement of the muscular system at a minimum risk of trauma to the muscular-skeletal system. In the original Pilates' instrument, resistance of each of the springs was 25 pounds (11.34 kg)[3,13,14].

Cadillac. It is a sort of a bed with tall arm-rests placed over the mat of this bed, with additional springs for resistance exercises. Broad useful-

Photo 3

„Active feet"

Photo 4

In supine position on one side, the waist raised over the ground in order to increase stabilisation of the pelvis

ness of this instrument in rehabilitation of patients with significant disability results from the possibility to perform exercises without the necessity to assume a standing position[14].

Wunda Chair (Stability Chair). Pilates introduced this instrument into his training system taking advantage of his experience with training of Chinese circus acrobats. It enables performance of several tenths of exercises primarily reinforcing abdominal muscles by performance of isolated small-range movements.

Other, very well known and original instruments from Pilates' studio include: Ped-a-Pul, Ladder Barrel, Arcs[14].

Swiss ball. Use of this instrument for Pilates' exercises increases requirements for the sensorimotor system, which is in accordance with the principles of the described method pertaining to improving stability of the body and of the neural-muscular balance. Size of the ball should be selected appropriately to the height of the exercising person so that the angle between the thigh and the calf is approximately 90 degrees in sitting position. Multi-planar exercises performed with this instrument increase consciousness of the body in space and improve deep sensation; moreover, they facilitate performance of many stretching and relaxation exercises[4,15].

Overball. It is a soft ball, of the diameter of approximately 25 cm that can be used as an instrument increasing the difficulty level of performance of an exercise (unstable support for a fragment of the body) or aiding in local relaxation of certain muscle groups.

Bands and tubings. These instruments can replace springs in the original Pilates' equipment or be used independently for resistance exercises. Bands and tubings of different resistance force are available, depending on the needs and skills of the exercising person**.** Pilates' exercises by a gymnastic bar, with use of a stick, a chair, various types of pillows with different instability levels (the so-called balance trainers) or using other instruments are also used.

Forms of combined training are also suggested, where the classical method of the Pilates' system is complimented with other forms of motor activity, e.g. dance, yoga, or sport training. It is recommended to perform Pilates' exercises 3-6 times a week[3].

METHODOLOGICAL PRINCIPLES OF PILATES' EXERCISES

At physiological conditions, skeletal muscles do not perform an isolated work but cooperate in order to create a coordinated motor pattern. This is referred to as work in bio-kinematic chains.

If the distal part of the chain is not stabilised and movements of particular joints within this chain are independent of each other, the chain is referred to as open chain. This type of work, primarily activating the agonistic and synergistic muscles, is characteristic for the majority of every-day activities performed by the upper extremities. In the Pilates' method, „the hundred" is an example of the exercise performed in an open chain (Figure 1).

If the distal part of the chain remains stabilised and a movement in one joint is accompanied by simultaneous movement in the adjacent joints, this constitutes a work in a closed bio-kinematic chain. During this activity, simultaneous activation of the agonists, antagonists and synergistic muscles occurs. The Diamond Press (Figure 2) is an example of classical Pilates' exercise performed in a closed chain. Therefore, the described method constitutes a combination of exercises in open and closed chains[1].

Pilates' exercises form proper habitus of the exercising persons, because re-education and reinforcement of the muscle-fascial system starts from the body centre, from the spine (the inside-out)[1,3]. Movement habits associated with activities of daily living, type of job, dancing or sport discipline can lead to syndromes of muscular imbalance thus disturbing the system of normal body posture. Performance of exercises according to the Pilates' technique enables improvement of muscular balance disturbances, beginning with the body centre, i.e. the trunk and the pelvic girdle. It seems that such method of training with reconstruction of core stabilisation and force allows minimising multiple pain ailments associated with improper shifting of load, especially within the lower spine and the hip and knee joints. The load as-

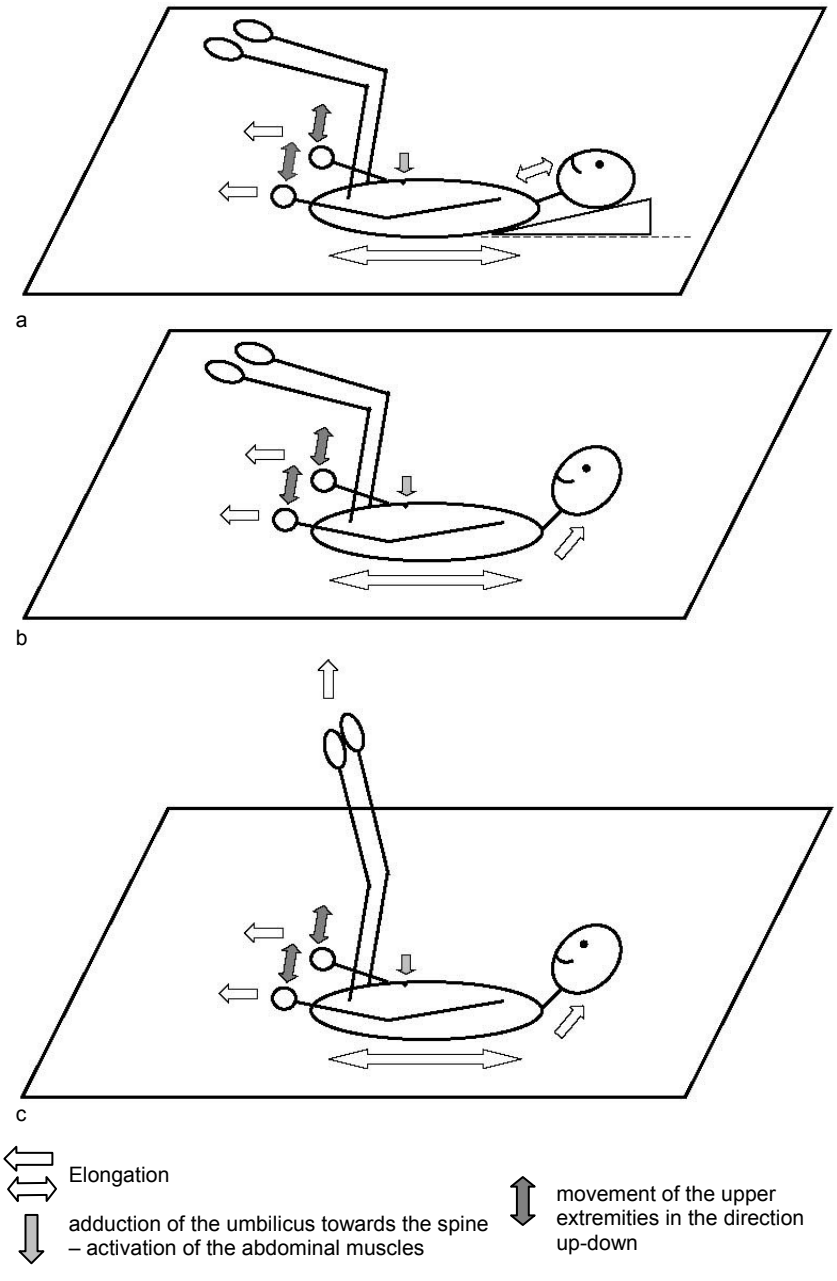


Figure 1

Exercise 'the Hundred'

The name of the exercise stems from its performance to 10 repeated sets (10 times x 10 respiratory cycles = 100 times „pumping")
a) Level 1:
Baseline position: lying supine on the back, the pelvis at neutral position. With expiration – pulling one leg towards the abdomen, inspiration, with next inspiration – pulling the second flexed leg towards the abdomen, the scapulae retracted in the direction of the buttocks, neck muscles relaxed, arms distant from each other („open thorax"), arms slightly raised above the ground, palms parallel to the ground and at maximum distance from the arms.
Movement: Inspiration and slight vertical movements of the arms with counting to 3-5, with expiration – further „pumping" with counting to 3-5. The movement is repeated 5 to 10 times.
b) Level 2:
Baseline position: head and the upper part of the thorax raised over the ground (chin far from the sternum – eliminating overloading of the neck), the other elements of the position – as in the Level 1.
Movement: as in the Level 1
c) Level 3
Baseline position: as in Level 2
Movement: Inspiration, with expiration – extension of the legs in the knees, „active feet" and further, as in the description for Level 2

sociated with maintenance of the erect posture (in opposition to the gravitational force) is mainly balanced by the activity of deep spine stabilisers. Large muscle groups located more externally may be involved in performance of the actual active movement during this process, while not „using" the majority of energy for activity associated with stabilisation, which – in such a situation – frequently results in muscle contraction and disturbance of joint functioning. Such training assumptions can also be found in other systems of motor re-education (Structural Integration, Feldenkrais method), in Eastern forms of physical and mind exercises (Yoga, Tai Chi) and in physiotherapeutic methods (PNF, SET and other)[10,16,17,18].

As already mentioned, Pilates' technique aims at improvement of nerve-muscle integration by consciously influencing the movement and reinforcement of the whole muscular system. Normal functioning of the human motor system requires good cooperation of two coupled muscular systems. The deep system, referred to as „core", acts locally as stabiliser and initiates each movement. This is confirmed by studies by Panjabie[19], where he demonstrated that in normal conditions, stabilisation always precedes any active movement („stabilisation is pre-movement"[16]). This phenomenon was previously also described by Rolf – the founder of the method known as Structural Integration (Rolfing)[20].

The superficial muscle-fascial structures, referred to as „movers", is directly involved in performance of an active movement and helps in creating stabilisation of the body as a whole[1].

Pilates' method assumes the „inside-out" effects on four slings forming the superficial muscular system:

Posterior oblique sling is mainly formed by the latissimus dorsi muscle and the contralateral gluteus maximus. This diagonal system of muscular associations helps in stabilising the sacroiliac joint in the loaded lower extremity (Figure 3).

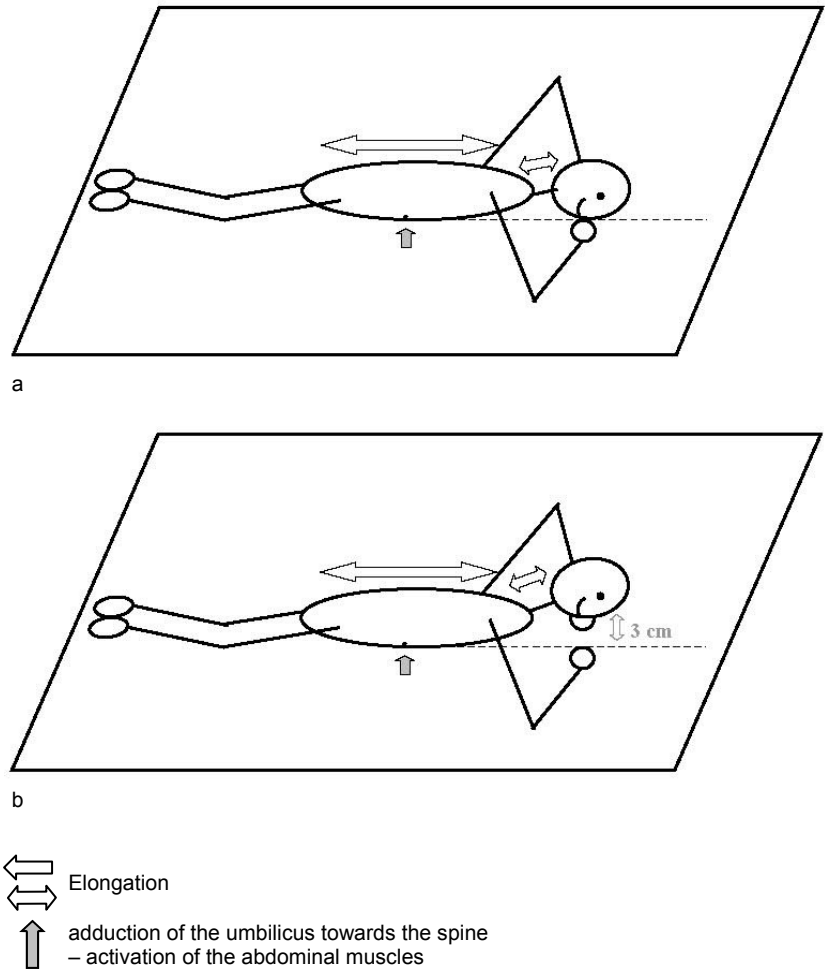


Figure 2

Exercise 'the Diamond Press'

a) Baseline position: lying supine on the abdomen, elbows flexed, forehead supported by the hands (forming a shape of a diamond), scapulae retracted towards the buttocks, feet spread to the width of the hips
b) Movement: Inspiration, with expiration – adduction of the umbilicus towards the spine, correction of head position: moving it further and further from the line of the shoulders – „elongation" of the neck with raising the head by 3 cm over the ground, inspiration, expiration with the „core" tensed – return to the baseline position.
During performance of the exercise, the sight is directed to the fingers.

Posterior longitudinal sling containing the extensor of back with its fascia and the biceps of thigh. The sling also helps in stabilising the sacroiliac articulation (Figure 4).

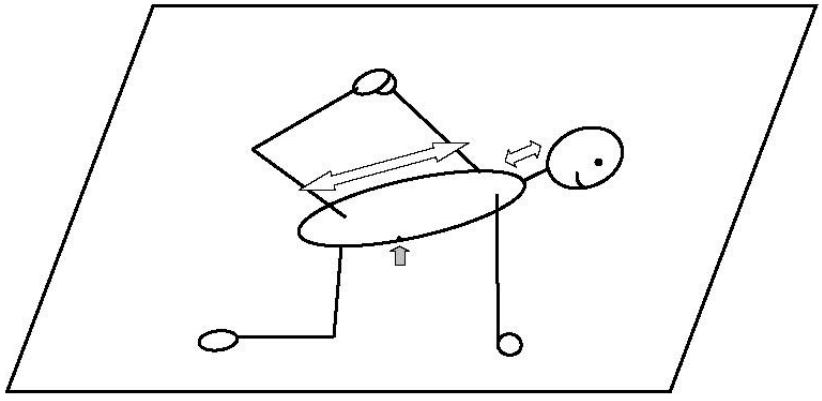
Anterior oblique sling is formed by the oblique muscles of abdomen with the anterior (abdominal) fascia and contralateral muscles adducting the hip. The sling assists the transverse muscle of abdomen in stabilising the trunk and the pelvic girdle.

Lateral oblique sling is formed by gluteus medius and gluteus minimus muscles as well as ipsilateral muscles adducting the hip. Contralateral quadratus muscle of loin is also included in this group by some authors. Activation of this system helps in stabilising the pelvis during standing, during walking and other activities such as climbing up and walking down the stairs. Function of this sling is limited in case of the lack of stability in the sacroiliac joint[1].

APPLICATION OF PILATES' METHOD IN PHYSIOTHERAPY – OVERVIEW OF LITERATURE

Despite more than 70-year use of Pilates' method in medical rehabilitation[21], there have been very few publications in the scholarly literature on physiotherapy and similar disciplines pertaining to use of this method of motor activity in rehabilitation of patients. Theoretical principles of this method point out to a possibility of its use in patients with various types of orthopaedic-neurological dysfunctions, both in prevention (primary and secondary) and in group and individual therapy. However, reliable studies on the effects of use of this physical exercise system, according to principles of Evidence Based Medicine, have to be based on multimonth, controlled and randomised observations conducted in a large group of patients[22]. Results of studies published so far are based on case studies or were conducted in groups not larger than 40 persons. The majority of publications were short reports and continuation is warranted. Most of the studies were conducted in patients with low back pain. Application of Pilates' gymnastics in those patients resulted in reduction of ailments[23], likely via reinforcement of the deep muscles of the trunk and education as to appropriate performance of every-day activities that were frequently the cause of pain. Advantages of use of Pilates' system in this group of patients are comparable with results obtained when exercises of the Back School are performed[24]. Therefore, application of both methods as alternatives may be considered. According to Rydeard et al.[25], use of Pilates' method in patients with lumbar spine pain additionally decreases the degree of perceived disability (as measured by the Roland Morris Disability Questionnaire – RMQ/RMDQ-HK), as compared to traditional physiotherapeutic methods. Importantly, the achieved results persist as long as even for one year following termination of exercise program. Yet, as there have been very few publications confirming efficacy of this therapeutic method in patients with spinal pain, some authors are against use of Pilates' exercises in the process of treatment of patients with these ailments[26].

Few reports on a possibility of using Pilates' method in physiotherapy of patients with scoliosis refer to management of single



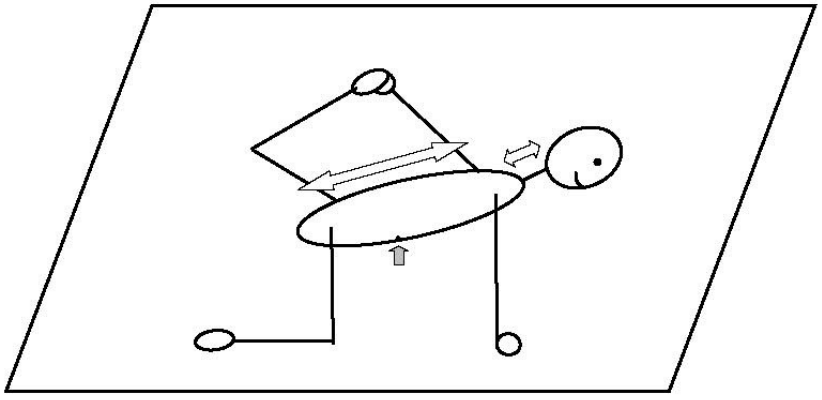
Elongation

adduction of the umbilicus towards the spine
– activation of the abdominal muscles

Rycina 3

Exercise activating the Posterior Oblique Sling[1]

At a supported kneeling position, holding with the left arm onto the right foot of the leg flexed in the knee and extended in the hip joint.



Elongation

adduction of the umbilicus towards the spine
– activation of the abdominal muscles

Rycina 4

Exercise activating the Deep Longitudinal Sling[1]

At a supported kneeling position, holding with the left arm onto the left foot of the leg flexed in the knee and extended in the hip joint.

cases, while reliable general conclusions cannot be drawn based on such data[27]. Nonetheless, it is suggested that the method may be applied in the treatment of abnormalities resulting from scoliosis, such as disturbances of balance, deep sensation, muscle tone[28].

Results of a study by Segal et al.[29] indicate a positive influence of Pilates' exercises in increasing flexibility (the Fingers-to-Floor test) in adult persons after 2, 4, and 6 months of exercises performed for one hour per day, 5 days a week. In the same study, however, no effects of the described exercise method on self-assessment of health status in healthy persons or on lean body mass (LBM). The authors, however, emphasise a small number of the evaluated group (32 persons) and indicate that studies assessing Pilates' exercises on muscle strength of trunk stabilisers should be continued in a larger population.

Similar studies (exercises performed for 1 hour daily, for 5 days a week, during a period of 4 weeks) were conducted in a group of 11-year old girls. The results demonstrate an interest of the evaluated persons for this form of activity, which may be used for increasing the level of physical activity and as one of the methods combating obesity in teenagers[30].

Lugo-Larchewegue et al.[31] describe a case of use of Pilates' method in treatment of recurring lower extremity trauma, induced by its improper positioning during running. Exercises aimed at multiplanar, dynamic reinforcement of the muscles of the lower limb, the pelvis and trunk, allowed return to light athletic trainings after 12 months.

Some of the Pilates' exercises can be performed by pregnant women. Because of the pregnancy-associated changes in the muscle-skeletal system, skilful reinforcement of deep muscles of the trunk and pelvis is recommended for appropriate maintenance of body mechanics[32]. Advanced pregnancy can cause disturbances of balance and deep sensation, which constitutes a potential cause or trauma; therefore, in Pilates' programs, apart from reinforcing and increasing elasticity of the muscles, much attention is dedicated to exercises of maintenance of balance. Learning and training proper breathing pattern is also of great importance. It is noteworthy that for physical and mental health of a woman, it is essential to return to full physical activity as soon as possible after delivery.

Parts of the Pilates' method are also applied in sports medicine. They may be complimentary to traditional training methods, e.g. they may improve jumping abilities of gymnasts[33]

and may be used in therapy of traumas of feet, knees and spine of ballet dancers[34].

Because of the global form of the performed movements, aiming at improvement of both strenght and elasticity of the muscles, as well as of balance and body coordination and posture, Pilates' exercises can also be used in elderly persons. Studies of Mallery et al.[35] demonstrate that at certain range, they can be performed even by patients of old age (mean age of the evaluated persons: 82 years). By learning correct posture and body biomechanics during every-day activities, Pilates' exercises may significantly reduce the risk of falls in the elderly.

The principle of moderate dynamics of the performed exercises, characteristic for the Pilates' method, eliminating fatigue of the exercising muscles, suggests that elements of the method could be used in rehabilitation of patients with MS, Parkinson's disease or in post-stroke patients[36]. The opinion, however, results solely from theoretical principles of the Pilates' system and is not supported by appropriate clinical trials.

SUMMARY

The described technique of exercises can be considered safe, because smooth movements at moderate dynamics, with preservation of articular stability, minimise the risk of injury. The form of Pilates' training can be adjusted to needs of many patients, at different age groups. Especially the elderly can take an advantage of this calm, non-aerobic form of training provided they exercise on a regular basis. Introduction of these exercises into rehabilitation programs aiming at prevention of falls by means of balance and gait improvement in the group of elderly people should be considered[37]. It should alse be stressed out that the method is suited for patient persons who are willing to and able to concentrate on performance of a precise movement associated with appropriate breathing. Further, the method requires that persons conducting the exercises not only possess practical skills but have also solid theoretical knowledge (knowledge of functional anatomy and human physical effort physiology).

In the described exercise system, special attention is paid to form the ability of correct[6] body core stabilisation, which is to be ensured by activation of the structures placed in direct proximity to the spinal column. Increasing the ability to maintain static and dynamic balance by creating a habit of maintaining the spine at neutral position (balanced with regard to gravity) is reflected in a more economic and easier performance of activities of daily-living. It can be, therefore, assumed that currently, when back pain is a serious social problem, the method may become useful in the therapy of many ailments associated with bad motor habits leading to weakening of the deep system stabilising the spine and to disturbances in muscular balance. The possibility to perform Pilates' exercises without instruments and at open space (e.g. on a beach, a meadow) indicates broad usefulness of the method in group and individual therapy of the patient[7]. It is noteworthy that Pilates' exercises, possible to be performed both in conditions of unloading and of graded loading, should always be selected according to patient's individual needs, depending on patient's local and general status[36].

Finally, the necessity to conduct reliable clinical studies verifying the effectiveness of the Pilates' method and determining indications for its use should be emphasised. Such studies would also constitute a solid basis for introducing teaching of Pilates' exercises at schools offering knowledge on physiotherapy[36].

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